

Re-thinking Economic Modelling: The Importance of Net Worth

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Abstract

This article presents a novel approach to economic modelling; it is rigorous, yet simple and intuitive. The central feature is the *balance sheet*, and the *net worth* of individuals and groups is of crucial importance. Changes in balance sheets and net worth correspond directly to the core areas of economic study: production, distribution and consumption. Balance sheets plainly show debts (and therefore almost all modern money), making the model particularly suitable for analysing insolvency and financial crises.

The balance sheet model reliably links individual events to the macroeconomic level since *there is no fallacy of composition*, either when aggregating the balance sheets of any group of individuals, or when finding the combined effect of any set of economic actions. As a result, the model can be used as a touchstone for other economic models and theories, either lending support or introducing doubts, depending on the compatibility of their conclusions with those resulting from a net worth analysis.

In particular, the model casts doubt on the claim that there is a paradox of thrift, simply by demonstrating that it is straightforward for every person to increase their net worth concurrently.

JEL B41, B59, D00, E00
Keywords Net worth
Balance sheet
Macroeconomic model
Insolvency
Thrift

Introduction

Core economic theory in recent centuries has focussed on *flows*—the rate of change of values per unit time. Measures which are flows include production, consumption, supply and demand.

This article argues that the answer to Queen Elizabeth II’s question on visiting the London School of Economics, “Why did nobody notice [the approach of the financial crisis of 2007-9]?” (Pierce 2008), is that economists and policy makers frequently overlook the constraints on flows which are imposed by *stocks*—quantities existing at a point in time. In particular, *people cannot sustain their demand in the face of a declining net worth*. Therefore this article deals mostly with a study of people’s net worth.

In this article, a *person* means either a natural person, or a *corporation* such as a limited liability company, a government, or a charitable organisation.

A *debt* is a promise by one person—the *debtor*—to give a tangible asset to¹, or perform a service for, another person—the *creditor*—at some point in the future.

Every person may own some tangible assets, may be owed some debts by other people, and may owe some debts to other people. Of these three, the first two together are the person’s *assets*, and the third are the person’s *liabilities*. In this article, the debts owed to a person will be called that person’s *debt assets*.

A person’s assets and liabilities can be shown on a *balance sheet*—such as Figure 1. A balance sheet also shows *net worth*, which is the sum of the assets minus the sum of the liabilities:

$$\text{Net Worth} = \text{Assets} - \text{Liabilities}$$

or

$$NW^P = \sum_i T_i^P + \sum_j C_j^P - \sum_k D_k^P$$

where NW^P is person P ’s net worth, $\{T_i^P\}$ are P ’s tangible assets, $\{C_j^P\}$ are P ’s debt assets, and $\{D_k^P\}$ are P ’s liabilities. A person’s net worth is a reasonable measure of their wealth.

| Assets | Liabilities |
|---|---|
| House (11 High Street, Sometown) | £125,000 (Mortgage – Bank A) |
| Car (reg. XY 08 WSE) | |
| Wristwatch (Acme Watches model Q) | |
| £1,000 (Savings – Bank B) | |
| | Net Worth: |
| | House + Car + Wristwatch |
| | – £124,000. |
| Total: House + Car + Wristwatch + £1,000 | Total: House + Car + Wristwatch + £1,000 |

Figure 1: An example person’s balance sheet

Importantly, in this article, balance sheets consist of *the assets and liabilities themselves*, not some monetary value for each. Similarly, the net worth consists of the

¹Or give a debt asset to, or take a liability from. See below.

difference between the actual assets and the actual liabilities². While this means that, as in Figure 1, net worth cannot be expressed simply as a single value in some homogeneous unit of account, the crucial advantage is that net worth is a direct measure which does not vary with people’s sentiment or behaviour, and is immune to considerations of inflation, or indeed to the existence of money at all. Keynes’s initial perplexity in the choice of units (Keynes 1936: Chapter 4) is completely avoided. The model applies equally well to:

- an individual on a desert island,
- an informal economy using barter or commodity money, or
- a complex industrialised society of many millions of people, with a sophisticated financial system.

It should be emphasised here that *money* today generally refers to a debt asset which is a liability of either the central bank or a commercial bank (McLeay et al. 2014). Therefore, the balance sheet model inherently encompasses not only the existence of money, but also the important processes of its creation and destruction.

As this article will show, simple arithmetical laws apply to the changes in net worth resulting from economic events.

1 The Origin and Destination of Balance Sheet Entries

Over time, a person’s balance sheet changes, as entries are added or removed. Each change is a result of an economic *action*, and these actions can be categorised according to:

- the type of change made to the person’s balance sheet, and
- the simultaneous type of change made to another person’s balance sheet, if any.

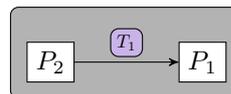
The analysis below examines the possible economic actions which cause the addition or removal of each type of balance sheet entry (tangible asset, debt asset and liability). It demonstrates that *there are exactly 8 atomic economic actions, from which all economic activity is composed*.

1.1 Addition of Tangible Asset

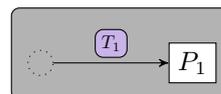
When person P_1 has a tangible asset T_1 added to their balance sheet, either:

1. T_1 was previously on the balance sheet of another person, say P_2 ; or
2. T_1 was previously not on anyone’s balance sheet.

Case 1 is a *transfer of a tangible asset* T_1 from P_2 to P_1 .



Case 2 is *production* — T_1 is a new tangible asset which has been harvested, mined or manufactured.



²For brevity, Figure 1’s net worth does not show the details of exactly which house, car and wristwatch are included, but these *are* implicitly assumed. Clearly, houses etc. are not fungible.

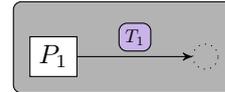
1.2 Removal of Tangible Asset

When person P_1 has a tangible asset T_1 removed from their balance sheet, either:

1. T_1 is subsequently on the balance sheet of another person, say P_2 ; *or*
2. T_1 is no longer on anyone's balance sheet.

Case 1 is another example of a transfer of a tangible asset.

Case 2 is *consumption* – T_1 no longer exists, having been (literally) consumed, used to destruction, or accidentally broken or destroyed.



1.3 Addition of Debt Asset

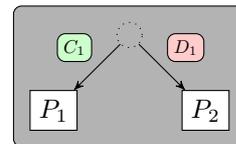
When person P_1 has a new debt asset C_1 added to their balance sheet, either:

1. C_1 was previously on the balance sheet of another person, say P_2 ; *or*
2. C_1 was previously not on anyone's balance sheet.

Case 1 is a *transfer of a debt asset* C_1 from P_2 to P_1 .



Case 2 is the *creation of a new debt*. There must be another person, say P_2 , who has a *new liability* $D_1 (= C_1)$ added to their balance sheet, since P_1 cannot be owed a debt if there is nobody who owes it.



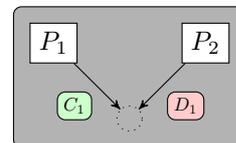
1.4 Removal of Debt Asset

When person P_1 has a debt asset C_1 removed from their balance sheet, either:

1. C_1 is subsequently on the balance sheet of another person, say P_2 ; *or*
2. C_1 is no longer on anyone's balance sheet.

Case 1 is another example of a transfer of a debt asset.

Case 2 is the *write-off of an existing debt*. In this case, there must be another person, say P_2 , who has a corresponding liability $D_1 (= C_1)$ removed from their balance sheet, since there is no longer anybody to whom the debt is owed.

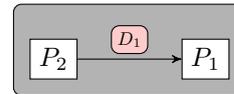


1.5 Addition of Liability

When person P_1 has a new liability D_1 added to their balance sheet, either:

1. D_1 was previously on the balance sheet of another person, say P_2 ; *or*
2. D_1 was previously not on anyone's balance sheet.

Case 1 is a *transfer of a liability* D_1 from P_2 to P_1 .



Case 2 is another example of a creation of a new debt, where another person has a new corresponding debt asset added to their balance sheet.

1.6 Removal of Liability

When person P_1 has a liability D_1 removed from their balance sheet, either:

1. D_1 is subsequently on the balance sheet of another person, say P_2 ; *or*
2. D_1 is no longer on anyone's balance sheet.

Case 1 is another example of a transfer of a liability.

Case 2 is another example of a write-off of an existing debt, where another person has a corresponding debt asset removed from their balance sheet.

1.7 Provision of Service

The provision of services, such as one person, P_1 , cutting the hair of another person, P_2 , is also a part of the study of economics. Receiving a service is typically of value to the recipient, even though their balance sheet may not be affected, and the recipient often gives something of value (or provides another valuable service) to the provider in exchange.

Say (1971: Chapter XIII) reasoned that service provision, such as the advice of a doctor, is equivalent to the simultaneous production, transfer and consumption of an *immaterial product*.



Since these three economic actions are already part of the balance sheet model, it is not strictly necessary to augment the model to include services explicitly. However, there are some situations where it can be useful to do this, so *provision of a service* is treated as a type of economic action in its own right in the balance sheet model.

1.8 Summary

Every time a balance sheet changes (or a service is provided), it is as a result of one of the actions described above:

1. Transfer of tangible asset
2. Transfer of debt asset
3. Transfer of liability
4. Creation of new debt
5. Write-off of existing debt

6. Production
7. Consumption
8. Provision of service

These are the 8 atomic actions of economics. A whole economy consists of unimaginably vast numbers of these actions. Despite this, macroeconomic analysis within this model is not only feasible, but actually *straightforward*, because the composition of these actions is *linear* i.e. the effect on balance sheets (and therefore net worth) of any arbitrarily large set of actions is *identical* to the sum of the effects of the individual actions.

Example. P_1 buys 100 strawberries from P_2 for £5. Then P_2 pays P_1 £15 to wash P_2 's car. P_1 also gives 5 strawberries to P_2 . The outcome is *identical* to P_1 washing P_2 's car, and P_2 giving **95** (= 100 – 5) strawberries and **£10** (= £15 – £5) to P_1 .

Section 3 examines the effects of each of the 8 atomic actions on the net worths of the participants, of every other individual person, and of a number of groups of people.

2 Aggregation of Balance Sheets

So far, balance sheets and net worth have been defined for an individual person. It is also possible to create an aggregate balance sheet for a group of people. Consider a group G , consisting of a set of people $\{P_n\}$. The group's tangible assets, T^G , are simply the sum of the tangible assets of all of the individuals in the group, and similarly for the group's debt assets, C^G , and liabilities, D^G :

$$T^G = \sum_n \sum_i T_i^{P_n} \quad (1)$$

$$C^G = \sum_n \sum_j C_j^{P_n} \quad (2)$$

$$D^G = \sum_n \sum_k D_k^{P_n} \quad (3)$$

From (1), (2) and (3), and defining the net worth of the group, NW^G in the natural way, we see that NW^G is the sum of the net worths of all the individuals in the group:

$$NW^G = T^G + C^G - D^G = \sum_n NW^{P_n} \quad (4)$$

2.1 Intra-Group Debts

There may be a debt owed by one member of the group to another member. In this case, the group's aggregate balance sheet contains both the debt asset and the liability for the same debt. As a result, the reduction in the group's net worth due to the liability exactly cancels out the increase of the group's net worth due to the debt asset. A debt owed by one member of a group to another has no effect *on the net worth of the group*. The debt *does*, however, continue to affect the net worths of the individual people within

the group who have the corresponding debt asset and liability, as well as any subgroups of the group which contain exactly one of these two people.³

2.2 Balance Sheet for the Whole World

In any closed economy, and in particular the whole world, it is impossible for debt assets or liabilities to be transferred to a person outside the economy. Therefore, within the whole world's economy, there is a one-to-one relationship between the debt assets and the liabilities on the aggregate balance sheet of all people:

$$\sum_j C_j^{\text{World}} = \sum_k D_k^{\text{World}} \quad (5)$$

From (4) and (5), we therefore have the interesting result that the net worth of the whole world is equal to the sum of just the tangible assets belonging to all of the people of the world:

$$NW^{\text{World}} = \sum_i T_i^{\text{World}} \quad (6)$$

3 Effects of Economic Actions on Net Worth

Section 1 discussed the different types of economic action, and their effects on balance sheets. This section discusses the changes due to each type of action on the net worths of the following people and groups:

- the individual participants,
- all participants as a group,
- every other individual person in the world,
- all non-participants as a group, and
- all people in the world as a group.

Where an action involves two people, P_1 and P_2 , the net worth of the group of all participants will be called NW^{12} ; when the action involves only one person, the group of all participants is simply P_1 , and the change to the net worth of this redundant group is not shown again.

The net worth of the group consisting of all non-participants will be called $NW^{\text{etc.}}$.

In each case, a diagram is shown, summarising the changes in terms of the effects on net worth of the participants. These net worth diagrams are an extremely effective and intuitive way to analyse important effects of a set of economic actions.

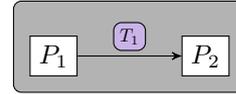
³Therefore, claims that domestic debt does not matter because *we owe it to ourselves* are incorrect. Debts are very important to the creditors, irrespective of whether settlement is a domestic or an international issue. If debts owed within a group did not matter, then *no* debts would matter because all debts are owed within the group of all people in the world. (See subsection 2.2).

3.1 Transfer of Tangible Asset

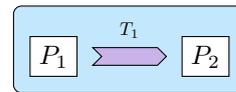
Tangible asset T_1 is transferred from P_1 to P_2 :

$$\begin{aligned}\Delta NW^{P_1} &= -T_1 \\ \Delta NW^{P_2} &= +T_1 \\ \Delta NW^{12} &= 0\end{aligned}$$

$$\begin{aligned}\Delta NW^P &= 0 && \text{for all } P \notin \{P_1, P_2\} \\ \Delta NW^{\text{etc.}} &= 0 \\ \Delta NW^{\text{World}} &= 0\end{aligned}$$



Since P_1 's net worth decreases by T_1 at the same time as P_2 's net worth increases by the same T_1 , this can be considered as a *transfer of T_1 of net worth from P_1 to P_2* , as indicated by the arrow in the diagram.

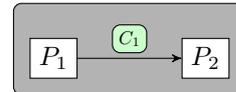


3.2 Transfer of Debt Asset

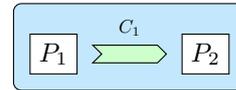
Debt asset C_1 is transferred from P_1 to P_2 :

$$\begin{aligned}\Delta NW^{P_1} &= -C_1 \\ \Delta NW^{P_2} &= +C_1 \\ \Delta NW^{12} &= 0\end{aligned}$$

$$\begin{aligned}\Delta NW^P &= 0 && \text{for all } P \notin \{P_1, P_2\} \\ \Delta NW^{\text{etc.}} &= 0 \\ \Delta NW^{\text{World}} &= 0\end{aligned}$$



This can be considered as a *transfer of C_1 of net worth from P_1 to P_2* , as indicated by the arrow in the diagram.

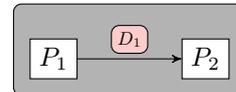


3.3 Transfer of Liability

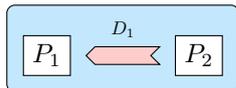
Liability D_1 is transferred from P_1 to P_2 :

$$\begin{aligned}\Delta NW^{P_1} &= +D_1 \\ \Delta NW^{P_2} &= -D_1 \\ \Delta NW^{12} &= 0\end{aligned}$$

$$\begin{aligned}\Delta NW^P &= 0 && \text{for all } P \notin \{P_1, P_2\} \\ \Delta NW^{\text{etc.}} &= 0 \\ \Delta NW^{\text{World}} &= 0\end{aligned}$$



This can be considered as a *transfer of D_1 of net worth from P_2 to P_1* , as indicated by the arrow in the diagram⁴.

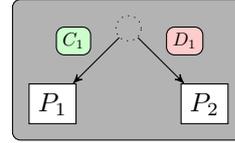


⁴The transfer of net worth is in the opposite direction to the transfer of the liability, since P_2 now owes the debt previously owed by P_1 .

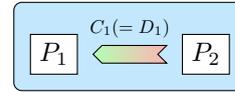
3.4 Creation of New Debt

P_2 agrees to owe P_1 a new debt. P_2 has a new liability D_1 , equal to P_1 's new debt asset C_1 :

$$\begin{aligned}\Delta NW^{P_1} &= +C_1 (= +D_1) \\ \Delta NW^{P_2} &= -C_1 (= -D_1) \\ \Delta NW^{12} &= 0 \\ \\ \Delta NW^P &= 0 \quad \text{for all } P \notin \{P_1, P_2\} \\ \Delta NW^{\text{etc.}} &= 0 \\ \Delta NW^{\text{World}} &= 0\end{aligned}$$



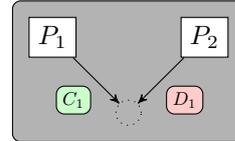
This can be considered as a *transfer of C_1 of net worth from P_2 to P_1* , as indicated by the arrow in the diagram⁵.



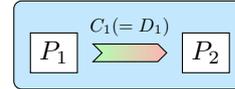
3.5 Write-off of Existing Debt

P_1 agrees that P_2 no longer owes the debt represented by P_2 's liability D_1 and P_1 's equal debt asset C_1 .

$$\begin{aligned}\Delta NW^{P_1} &= -C_1 (= -D_1) \\ \Delta NW^{P_2} &= +C_1 (= +D_1) \\ \Delta NW^{12} &= 0 \\ \\ \Delta NW^P &= 0 \quad \text{for all } P \notin \{P_1, P_2\} \\ \Delta NW^{\text{etc.}} &= 0 \\ \Delta NW^{\text{World}} &= 0\end{aligned}$$



This can be considered as a *transfer of C_1 of net worth from P_1 to P_2* , as indicated by the arrow in the diagram⁶.



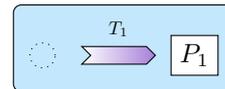
3.6 Production

P_1 produces a new tangible asset T_1 :

$$\begin{aligned}\Delta NW^{P_1} &= +T_1 \\ \\ \Delta NW^P &= 0 \quad \text{for all } P \neq P_1 \\ \Delta NW^{\text{etc.}} &= 0 \\ \Delta NW^{\text{World}} &= +T_1\end{aligned}$$



This causes an increase in P_1 's net worth, but unlike the economic actions above, there is no corresponding decrease in another person's net worth. *Production is the only action which increases the net worth of the whole world.*



⁵The colour gradient in the arrow indicates a transfer of net worth from debtor to creditor.

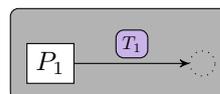
⁶The colour gradient in the arrow indicates a transfer of net worth from the creditor, who is no longer owed the debt, to the debtor, who no longer owes the debt.

Production generally involves some effort or sacrifice on the part of the producer in order to create the tangible asset. For example, the producer may need to labour, to consume raw materials, use equipment which is worn out in the process, spend time, and/or pay others for help.

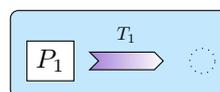
3.7 Consumption

P_1 consumes an existing tangible asset T_1 :

$$\begin{aligned} \Delta NW^{P_1} &= -T_1 \\ \Delta NW^P &= 0 \quad \text{for all } P \neq P_1 \\ \Delta NW^{\text{etc.}} &= 0 \\ \Delta NW^{\text{World}} &= -T_1 \end{aligned}$$



This causes a *decrease* in P_1 's net worth, but there is no corresponding increase in another person's net worth. *Consumption is the only action which decreases the net worth of the whole world.*

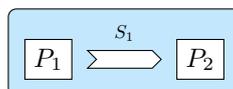


Consumption typically involves gaining some benefit from using up the tangible asset, such as obtaining nutrition and pleasure from eating a sandwich, although consumption can also mean damaging the asset, such as accidentally dropping and smashing a mobile phone.

Tangible assets may be partially consumed. A person who uses 500mAh of a battery with a charge of 1100mAh now has a battery with a charge of 600mAh. This could be visualised as the consumption of $\frac{5}{11}$ of a 1100mAh battery, but might be better considered to be the simultaneous consumption of a 1100mAh battery and production of a 600mAh battery, making the person's net worth decrease by (1100mAh battery – 600 mAh battery).

3.8 Service Provision

While Say's "immaterial product" view of services is sometimes useful, for diagrams showing the transfer of net worth, it is simpler to show the provision of a service simply as an arrow from the provider to the receiver.



Even if P_1 's and P_2 's net worths are unchanged, the arrow reflects the fact that P_1 has had to make an effort or sacrifice to provide the service, and P_2 has benefited by receiving it, similar to the production and consumption of a tangible asset as described in subsections 3.6 and 3.7 above.

3.9 Summary

In almost all cases, an economic action results in *no change* to the combined net worth of the participants, to any other person, or to the net worth of the whole world.

The only exceptions are *production*, which increases the producer's (and the whole world's) net worth by the new tangible asset, and *consumption*, which reduces the consumer's (and the whole world's) net worth by the consumed tangible asset.

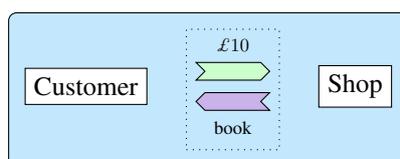
Production takes effort and sacrifice, for which the increase in net worth is some compensation—hopefully at least adequate. The loss of net worth due to consumption is hopefully compensated by the benefits gained from the consumption, e.g. the nutrition gained when eating food, the pleasure gained from creating a work of art when paints and canvas are consumed, or the chocolate cake gained when flour, sugar, butter, eggs, cocoa and a tablespoon of milk are consumed.

The only source of consumption is earlier production. The world's net worth is the stock of tangible assets which have already been produced, but not yet consumed.

4 Transactions

A *transaction* is a set of economic actions for which *either all or none occur*. For example, when a customer buys a book for £10 in cash at a shop, there are two actions:

1. A transfer of a debt asset—the cash—from the customer to the shop.
2. A transfer of a tangible asset—the book—from the shop to the customer.



These two actions form a transaction (illustrated with the dotted border) because the shop insists on receiving the cash in exchange for giving the book, and the customer insists on receiving the book in exchange for giving the cash.

Importantly, *each* of the two individual actions changes neither the combined net worth of the customer and the shop, nor the net worth of any other person. The transfer of the book increases the customer's net worth by the book at the same time as decreasing the shop's net worth by the book—similarly for the cash.

4.1 Types of Transaction

Not all transactions involve a voluntary exchange between two people. Some examples of transactions involving a single economic action are:

- A parent gives their child a football as a birthday present.
- A home owner pays £250 of council tax to the local government.
- A pickpocket steals the wallet of a person in a crowd.
- A person picks up a fallen tree branch to burn in a fireplace.

In the first three cases, there is no production or consumption, and so the combined net worth of the participants (parent and child, home owner and local government, pickpocket and victim) is unchanged as a result. In the fourth case, the person's net worth has increased by the new fuel.

It is also possible for transactions to consist of more than two economic actions, for example:

- A customer pays £100 for groceries at a supermarket, using a credit card.
 - The groceries are transferred from the supermarket to the customer;
 - The customer owes a new debt of £100 to the credit card company;
 - The credit card company owes a new debt of £98 to the supermarket.
 - The credit card company provides a service to the supermarket.
 - The credit card company provides a service to the customer.

4.2 Transactions in the Balance Sheet Model

The fundamental concepts of the balance sheet model are people, balance sheet entries, net worth, and economic actions. Transactions are not needed in analysing how each person's net worth is affected by the actions. And as seen above, some important economic actions are not a part of a multi-action transaction.

Much existing economic theory deals with transactions involving two parties—the study of supply and demand assumes that there is such an exchange. The very concept of price suggests that an equivalence between two things is established by their being freely exchanged by two people. In the book shop example of section 4 above, common economic theory considers that there is an objective equivalence between the value of the book and the value of £10 of cash.

The balance sheet model, on the other hand, does not equate the book given by the shop with the £10 given by the customer. All it does is to equate the book given by the shop *with the book received by the customer*, and to equate the cash given by the customer with the cash received by the shop. *Value* and *price* are not considered inherent properties of an object, but are subjectively determined by the participants at the time of agreeing a transaction, as Menger (1976: Chapter III) proposed.

Transactions are still a useful concept, however, as they help to explain people's motivations for performing economic actions, as illustrated in the book shop example.

Considering transactions also reveals that, in order for demand for a product to exist, buyers must provide either an agreed quantity of net worth or an agreed service in exchange. Buyers are only able to do this if they have sufficient net worth to do so⁷, or if they provide new services.

5 Further Macroeconomic Analysis

There are a huge number of economic actions which make up the dynamic behaviour of the macroeconomy. The effects of each individual action have been analysed, but a better intuitive understanding of the whole economy can be gained by collecting actions into related groups.

Traditionally, macroeconomic analysis groups actions by time, but this section shows two interesting alternatives. The first way groups together all economic actions in which a single person (or a single group) is a participant. The second way groups together all economic actions which involve a single tangible asset, a single debt (both the debt asset and the liability), or for completeness a single provision of a service.

⁷Buyers can actually buy even without enough net worth, but this is at the direct expense of their creditors. See subsection 6.2.

5.1 Lifetime of a Person

When a natural person is born, or when a corporation is first created, the person has an empty balance sheet—no assets, no liabilities, and zero net worth. Nobody else’s net worth is affected.

Over the lifetime of a person P , there are likely to be very many actions which affect P ’s balance sheet, and consequently P ’s net worth as analysed in section 3. Many, but by no means all, of these actions are likely to be part of a transaction in which P ’s net worth increases in one form and decreases in another.

At P ’s death (if P is a natural person) or winding up (if P is a corporation), a process of clearing all remaining entries from P ’s balance sheet takes place. The empty balance sheet can then be discarded.

This clearing of the balance sheet involves first paying P ’s liabilities, either directly from P ’s assets or from the proceeds of selling some of the assets. When either no assets or no liabilities remain, the final action is either:

- A transfer of any remaining assets from P to W , or
- A write-off by W of any remaining liabilities owed by P

where W is the group of every person in the world except for P .

At any point in time, the exact net worth of P , NW^P , can be stated in terms of the economic actions to date which involved P . The following notation for actions will be used:

| | | |
|---|------------------------------|--|
|  | π_i^P | Production of a tangible asset by P . |
|  | κ_i^P | Consumption of a tangible asset by P . |
|  | $T_i^{\overrightarrow{PW}}$ | A transfer of a tangible asset from P to W . |
|  | $C_i^{\overrightarrow{PW}}$ | A transfer of a debt asset from P to W . |
|  | $D_i^{\overrightarrow{PW}}$ | A transfer of a liability from P to W . |
|  | $CD_i^{\overrightarrow{PW}}$ | Creation of a new debt owed by P to W . |
|  | $WD_i^{\overrightarrow{PW}}$ | Write-off of a debt owed by P to W . |

This gives (the change in⁸) P ’s net worth at any point in time as:

$$\begin{aligned}
 \Delta NW^P &= \sum_i \pi_i^P - \sum_i \kappa_i^P \\
 &\quad - \sum_i T_i^{\overrightarrow{PW}} + \sum_i T_i^{\overleftarrow{WP}} - \sum_i C_i^{\overrightarrow{PW}} + \sum_i C_i^{\overleftarrow{WP}} \\
 &\quad + \sum_i D_i^{\overrightarrow{PW}} - \sum_i D_i^{\overleftarrow{WP}} \\
 &\quad - \sum_i CD_i^{\overrightarrow{PW}} + \sum_i CD_i^{\overleftarrow{WP}} + \sum_i WD_i^{\overrightarrow{PW}} - \sum_i WD_i^{\overleftarrow{WP}} \quad (7)
 \end{aligned}$$

where actions are summed over P ’s lifetime so far.

⁸Since P starts with zero net worth, the change in P ’s net worth over P ’s lifetime is simply P ’s current net worth.

Similarly, the change in net worth of W over P 's lifetime can be stated exactly as:

$$\begin{aligned}
\Delta NW^W &= \sum_i \pi_i^W - \sum_i \kappa_i^W \\
&+ \sum_i T_i^{\overrightarrow{PW}} - \sum_i T_i^{\overrightarrow{WP}} + \sum_i C_i^{\overrightarrow{PW}} - \sum_i C_i^{\overrightarrow{WP}} \\
&- \sum_i D_i^{\overrightarrow{PW}} + \sum_i D_i^{\overrightarrow{WP}} \\
&+ \sum_i CD_i^{\overrightarrow{PW}} - \sum_i CD_i^{\overrightarrow{WP}} - \sum_i WD_i^{\overrightarrow{PW}} + \sum_i WD_i^{\overrightarrow{WP}} \quad (8)
\end{aligned}$$

where all actions are again summed over P 's lifetime so far.

From (7) and (8),

$$\begin{aligned}
\Delta NW^W &= \sum_i \pi_i^W - \sum_i \kappa_i^W \\
&+ \sum_i \pi_i^P - \sum_i \kappa_i^P \\
&- \Delta NW^P \quad (9)
\end{aligned}$$

i.e. W 's net production plus P 's net production minus P 's net worth.

Once P 's balance sheet has finally been cleared, and P again has zero net worth, (9) shows that P 's contribution to the net worth of the rest of the world over P 's lifetime was simply P 's net production. If P was a net consumer in their lifetime, this excess must have reduced the rest of the world's net production.

5.2 Lifetimes of Tangible Assets, Services and Debts

An alternative way to analyse the whole economy is to form one group of economic actions per tangible asset, one group per debt (including both the debt asset and the liability), and one group per service. This analysis provides interesting insights into Say's claim that "it is production which opens a demand for products" (Say 1971: Chapter XV).

5.2.1 Tangible Asset

A tangible asset first appears on a balance sheet when it is produced. It may subsequently be transferred from one person's balance sheet to another's, and is ultimately removed from the final person's balance sheet when it is consumed.

Let the tangible asset be T_1 , the producer be O_0 (' O ' for owner), the consumer be O_n , and any intermediate owners be $\{O_1, O_2, \dots, O_{n-1}\}$. The chain of ownership is illustrated in Figure 2:

This could, for example, represent the lifetime of a packet of cornflakes, where O_0 is the producer⁹, O_1 is a wholesaler, O_2 is a retailer, and $O_3 (= O_n)$ is the consumer.

The effects of these economic actions on each person involved are shown in Table 1:

⁹ O_0 is also the consumer of the maize used to make the cornflakes, but the maize belongs to its own lifetime diagram

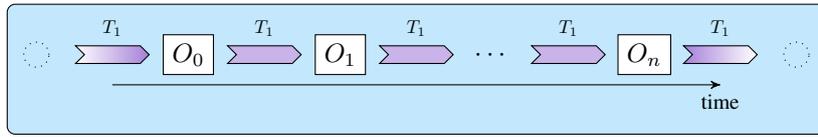


Figure 2: Chain of all economic actions involving a single tangible asset

Table 1: Effects of actions in chain on participants' net worth

| Person | Effect |
|-----------|---|
| O_0 | Effort is applied. (Net worth may also be reduced by consuming raw materials in making T_1 , and perhaps in paying others for help in the production). |
| O_1 | Each person O_i first receives T_1 , but subsequently transfers it to another person. O_i 's net worth is first increased by T_1 , and then reduced by T_1 , leaving O_i 's net worth as it would have been had T_1 been transferred directly from O_{i-1} to O_{i+1} . |
| \vdots | |
| O_{n-1} | |
| O_n | Receives benefits of consumption of T_1 . |

O_0 's effort and expense produced a product, but it was O_n who benefited from its consumption. In a free market economy, O_0 is compensated for this by being considered the initial owner of what they produce, allowing them to consume it themselves, or to exchange it for whatever another person is willing to offer. (Any economic action representing what is given in exchange belongs to its own diagram).

As shown in the table, each person in the chain from O_1 to O_{n-1} has their net worth increased by T_1 , and then reduced by T_1 , with the same outcome as if T_1 had been transferred directly from the person before them in the chain to the person after them. Since this applies for each of these people, the net effect of the chain of ownership is simply to transfer T_1 from the producer to the consumer.

5.2.2 Service

Providing and receiving a service, illustrated in Figure 3, are very similar to producing and consuming a tangible asset, although there is no intermediate person who first receives and then passes on the service as can be done with a tangible asset.

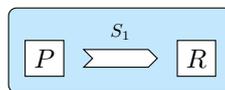


Figure 3: Chain of all economic actions involving a single service

P 's effort and expense provide the service, but it is R who benefits from receiving it. Again, in a free market economy, P is able to negotiate a mutually-satisfactory agreement with R , receiving something of value in exchange for providing the service.

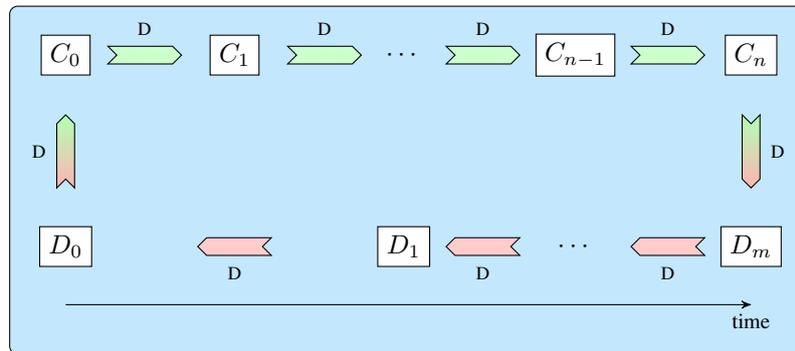


Figure 4: Loop of all economic actions involving a single debt

5.2.3 Debt

A debt is first created as a pair of debt asset and liability, each equal to D . Each half of the debt may be independently transferred from person to person, before the debt is finally written off, as illustrated in Figure 4.

When the debt is first created, net worth of D is transferred from D_0 to C_0 . Every time the debt asset is transferred from C_i to C_{i+1} , net worth of D is transferred, also from C_i to C_{i+1} . Every time the liability is transferred from D_j to D_{j+1} , net worth of D is transferred *in the opposite direction* from D_{j+1} to D_j . Finally, when the debt is written off, net worth of D is transferred from C_n to D_m .

The net effect of all of these actions is *zero for every person involved*. Each person either has their net worth increased by D , and then decreased by D , or vice-versa.

5.3 Summary

Every single economic action, which has ever occurred, or will ever occur, belongs to *exactly one* of these chain or loop diagrams.

A tangible asset is produced, then transferred along a chain of ownership from the producer to the consumer, and finally consumed. The combined effect of the chain of transfers is the same as if the producer had transferred the tangible asset directly to the consumer. Services are similar. However, the effect of all actions related to a given debt is exactly zero for every person involved.

Therefore, the combined effect of all economic actions throughout the economy over the whole of time *ultimately* amounts to nothing more than:

1. Some people produce tangible assets, and either consume the assets themselves, or transfer them to other people who consume them.
2. Some people provide services, which benefit either themselves or other people.

The purpose of very many economic actions, whose effects are ultimately reversed for at least one of the parties involved, is to break extraordinarily complex transactions into much simpler ones. Each involves a small number of parties—typically just two—and leaves each party satisfied with the intermediate state, in which each person is one step closer to being fully satisfied with the outcome.

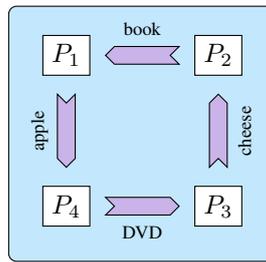


Figure 5: Desired 4-action transaction in examples

5.4 Examples

This process of breaking complex transactions into simpler ones can be illustrated by the following examples¹⁰. In each example, four people have produced a tangible asset, but want to exchange it for a different tangible asset. P_1 has an apple and wants a book, P_2 has a book and wants some cheese, P_3 has some cheese and wants a DVD, and P_4 has a DVD and wants an apple, as illustrated in Figure 5.

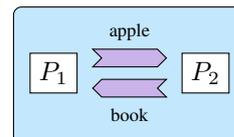
If all four people are aware of each other, of each other's assets, and of each other's wants, they could all meet and engage in a 4-action transaction, so each achieves their aim. However, even four people meeting to make a one-off exchange is likely to be difficult to coordinate, and the approach is completely impractical given the number of economic actions in which people engage.

Instead, they are able to break the single transaction into multiple transactions, and still achieve the same result in a number of different ways.

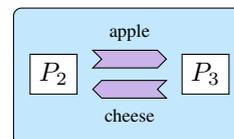
5.4.1 Example 1—Using Tangible Asset to Transfer Net Worth

One way to split the complex transaction into smaller transactions is through barter—transferring a tangible asset not for the receiver's consumption, but simply as a way to transfer net worth.

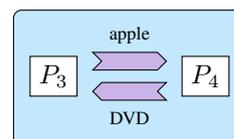
P_1 can meet P_2 , and exchange the apple for the book, fully satisfying P_1 , but leaving P_2 still with a valuable asset.



P_2 now has an apple, but wants some cheese. By meeting P_3 , P_2 can make the exchange and be fully satisfied, having exchanged a book for the cheese.



P_3 now has an apple, but wants a DVD. By meeting P_4 , and exchanging the apple for the DVD, both P_3 and P_4 are also fully satisfied with the outcome— P_3 has exchanged cheese for a DVD, and P_4 has exchanged a DVD for an apple.



One transaction involving 4 people and 4 actions has been converted into 3 separate transactions, each involving 2 people and 2 actions, by changing one of the 4 original

¹⁰For simplicity, the production and consumption steps are not shown.

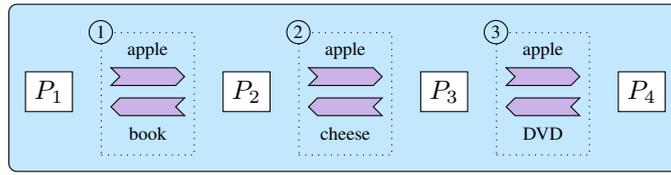


Figure 6: Using barter to break complex transaction into simpler transactions

actions into 3 separate actions, as illustrated in Figure 6. The combined effect of the 3 separate actions is identical to the original action—transferring the apple from P_1 to P_4 .

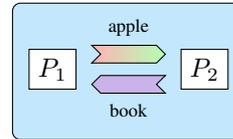
Breaking large transactions into three much simpler transactions reduces the need for the double (or multiple, as in the example) coincidence of wants. Each transaction is mutually acceptable, since net worth is transferred in both directions, and is a step towards final satisfaction.

5.4.2 Example 2—Using Debt to Transfer Net Worth

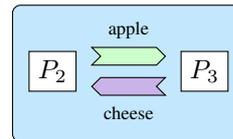
Where the social structure is such that people can normally rely on debts being paid, the means of avoiding the need for a double (or multiple) coincidence of wants is greatly expanded. Instead of transferring net worth by transferring an unwanted tangible asset, four extra possibilities are available: creating a new debt, transferring an existing debt asset, receiving an existing liability, or writing off an existing debt.

The same four people as above are in the same initial state.

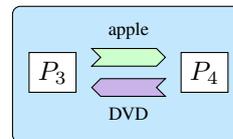
P_1 writes an IOU for one apple (new debt) to P_2 , who gives P_1 the book. P_1 has a liability of one apple, and P_2 has a debt asset of one apple.



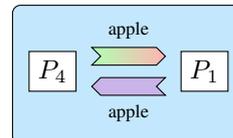
P_2 transfers the debt asset to P_3 in exchange for the cheese. P_2 is now fully satisfied.



P_3 transfers the debt asset to P_4 in exchange for the DVD. P_3 is now fully satisfied.



P_4 agrees to write off P_1 's debt in exchange for P_1 giving P_4 the apple. P_1 and P_4 are now both fully satisfied.



Once again, one transaction involving 4 people and 4 actions has been converted into separate transactions—4 in this case—each involving 2 people and 2 actions, as illustrated in Figure 7. For this scenario, 4 actions were added, where their combined effect was to do nothing: creating a debt, transferring the debt asset twice and writing

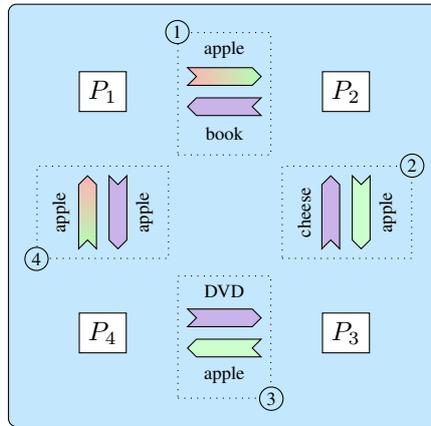


Figure 7: Using debt to break complex transaction into simpler transactions

off the debt.

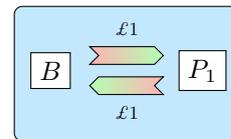
Using a debt has the advantage that tangible assets themselves do not need to be transferred, with the associated transport costs and risks of damage. In the case of an IOU for a perishable item, it also allows the debtor at any point in time to replace the item held as security for the debt with an equivalent substitute, and dispose of the previous security in any way they see fit.

5.4.3 Example 3—Using Money to Transfer Net Worth

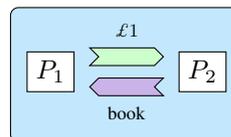
Using debt-related transfers of net worth relies on people trusting that the debts will be paid, which may work in a small community in which people know each other’s ability to pay debts. In a larger community, one person might not accept the IOU of a person whom they do not know. This is a situation where a banking system can help.

The same four people as above are in the same initial state, but there is also a bank, B .

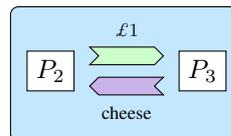
P_1 borrows $\pounds 1$ from B . This involves two economic actions. There is a new debt of $\pounds 1$ owed by P_1 to B . There is a *second* new debt (consisting of another debt asset and another liability), also of $\pounds 1$ owed by B to P_1 . This second debt is called a *deposit*, and is shown as a balance in P_1 ’s bank account. P_1 and B have each transferred $\pounds 1$ of net worth to the other.



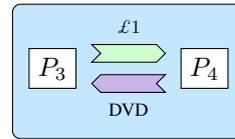
P_1 uses a cheque or bank transfer to transfer the $\pounds 1$ debt asset to P_2 in exchange for the book. P_2 trusts B more than P_1 as a debtor.



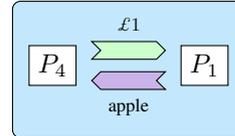
P_2 transfers the $\pounds 1$ debt asset to P_3 in exchange for the cheese. P_2 is now fully satisfied.



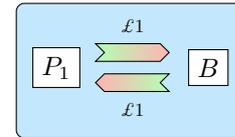
P_3 transfers the £1 debt asset to P_4 in exchange for the DVD. P_3 is now fully satisfied.



P_4 transfers the £1 debt asset to P_1 in exchange for the apple. P_4 is now fully satisfied.



P_1 repays the £1 loan to B . This also involves two economic actions. The £1 debt from P_1 to B is written off, and the £1 debt from B to P_1 (the deposit) is also written off. Both P_1 and B are now fully satisfied¹¹.



On this occasion, the original transaction involving 4 people and 4 actions has been converted into 6 transactions, each involving 2 people and 2 actions, illustrated in Figure 8. The loan debt is created, and later written off. The deposit is created, transferred 4 times, and then written off. As always, the combined effect of all actions over the lifetimes of each of these debts is to do nothing. This leaves the result identical to the original 4-person transaction.

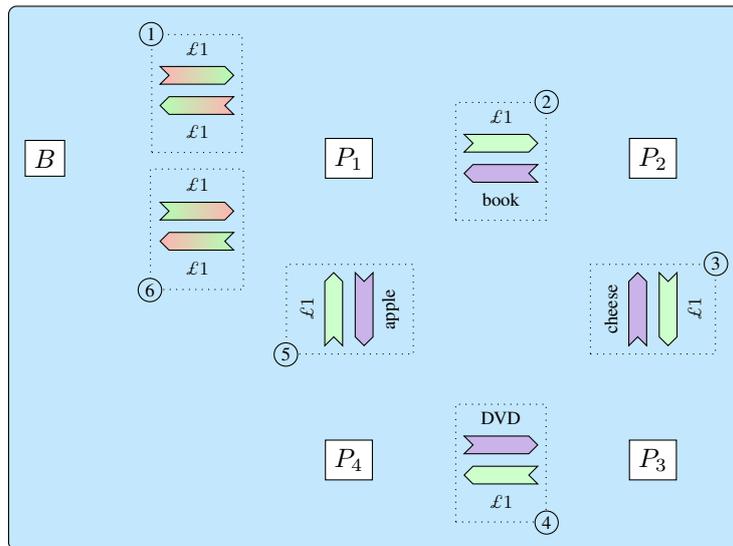


Figure 8: Using money to break complex transaction into simpler transactions

This removes the need for people to be able to assess each other's creditworthiness. Instead, the bank assesses the creditworthiness of the borrower, and people then only need to assess the creditworthiness of the bank.

The service provided by the bank is to promise to pay its creditors from its own net worth, whether or not the borrower repays the bank. Seen this way, a bank has much in

¹¹A proper treatment of the topic of interest requires a separate article

common with an insurer, and interest can be considered the insurance premium against the borrower defaulting.

6 Saving and Insolvency

6.1 Saving

A person's net worth is a measure of their resilience against a time when they are unable to produce as quickly as they are consuming, such as retirement, illness, famine or war. *Saving*, then, can be seen simply as *increasing ones net worth*.

While a person P_1 is able to increase their net worth at the expense of the net worth of the rest of the world (e.g. by buying something, and selling it at a higher price), they have the alternative of saving by *producing more than they consume*, which does not affect the net worth of the rest of the world at all.

In this sense of saving, therefore, *thrift is something in which all people can successfully engage concurrently*. Consider a macroeconomic example:

In year n , production is Y_n/year , and consumption is also Y_n/year . The aggregate net worth of all people in the economy at the end of the year is exactly equal to the aggregate net worth at the beginning of the year.

In year $n + 1$, however, production increases to $1.03Y_n/\text{year}$, but consumption remains at Y_n/year . The people have saved: they have added $0.03Y_n$ to their net worth. In year $n + 2$, production could revert to Y_n/year , and consumption remain at Y_n/year , in which case our situation is the same as year n , *except that the people have now increased their savings, and are more resilient against difficult times*.¹²

Alternatively, in year $n + 2$, production could remain at $1.03Y_n/\text{year}$, and consumption *increase* to $1.03Y_n/\text{year}$, and the people still have the increased savings accumulated in year $n + 1$.

6.2 Insolvency

A person is *insolvent* if they have more liabilities (whether due now or later) than they could pay *using the assets which they currently have*.

A full treatment of insolvency requires its own article, but an overview is important here, as one person's insolvency affects the meaning of the net worth of the rest of the world.

The reason that a debt asset is included as an addition to the net worth of a creditor is that there is an assumption¹³ that when the debt falls due, the debtor will give the creditor what the debt promises (in exchange for the debt being written off). A liability is included as a reduction in the net worth of the debtor for exactly the same reason. Net worth takes into account not just the current tangible assets owned by each person, but also future transfers which have been promised.

Usually, this gives a more realistic idea of how well off a person is. Consider two people, P_1 and P_2 :

- P_1 owns a house and a car, but has a mortgage debt of £400,000 due to be paid over 20 years, and no savings.

¹²This reduction in GDP to the level of year n could very easily be considered a recession, and yet there is no reason to suspect that anyone has suffered as a result.

¹³Often backed by the force of law.

- P_2 owns an identical house, but has no car. However, P_2 has no mortgage debt, and has savings of £30,000 at a bank.

P_1 has more tangible assets, but P_2 is clearly in a better position. For example, if P_2 wants or needs to buy a car at any point, they are able to buy one immediately with their savings. And if P_1 and P_2 each obtains £500,000 of income over the following 20 years, P_2 will have the full £500,000 to spend, but P_1 will only be able to spend £100,000, as they are required to give £400,000 to their creditor.

6.2.1 The Problem with Insolvency

The problem with insolvency is that the insolvent debtor does not have the means to pay all of their liabilities, meaning that the creditors will not get paid all that they are owed. Creditors' expectations about their future net worth is over-optimistic, which may lead them to make bad decisions—such as consuming more of their savings for pleasure now, in the incorrect expectation that their debt assets provide them with a sufficient stock of net worth for their needs in the future.

It is only if an insolvent debtor is able to increase their net worth by producing more than they consume that the rest of the world will receive what they have been promised. If that does not happen, the rest of the world will have to write off some of the debts owed to them by the insolvent debtor, at the expense of their savings.

6.2.2 Insolvency Example

Consider a desert island with a population of two people, P_1 and P_2 .¹⁴ P_1 wades out to the sea for 4 hours each day, and catches two fish to cook and eat. P_2 also wades out to sea, but for only 2 hours, sometimes catching one fish, and sometimes not catching any. After 2 weeks, P_1 has managed, by eating a little less some days, to save the equivalent of two cooked fish, illustrated in Figure 9.

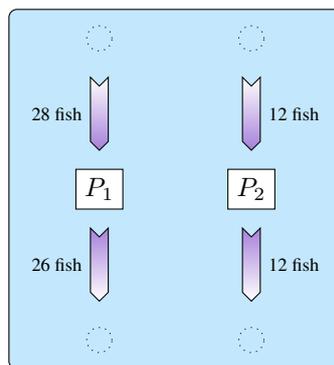


Figure 9: First two weeks of P_1 and P_2 catching fish; P_1 saves 2 fish

P_2 , on less successful days, offers to buy a fish from P_1 by writing an IOU for one fish, and P_1 agrees. After a year, P_2 has promised to pay P_1 50 fish. Figure 10 represents the whole year to date:

¹⁴Example inspired by Sanchez (2014), based on a cartoon by Irwin Schiff.

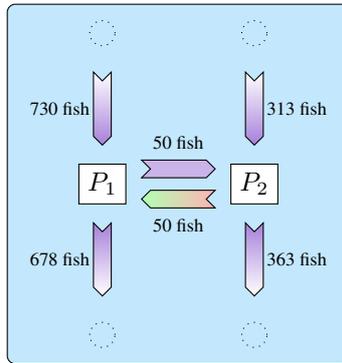


Figure 10: Whole year of P_1 and P_2 catching fish; P_2 borrows 50 fish

At this point, P_1 has produced 730 fish, consumed 678 fish, and given 50 fish to P_2 , leaving P_1 with a stock of 2 fish. P_1 also has a debt asset of 50 fish owed by P_2 . P_1 's net worth is therefore 52 fish, which appears to be enough to cope with a prolonged period of no food production e.g. a time of illness or working on another project.

P_2 , however, has produced 313 fish, received 50 fish from P_1 , and consumed 363 fish, leaving no stock of fish. In addition, P_2 has a liability of 50 fish owed to P_1 . P_2 's net worth is therefore -50 fish, meaning that P_2 is insolvent.

So even though P_1 appears to have savings of 52 fish, P_1 's insolvency means that their combined net worth is just 2 fish. Unless P_2 begins catching fish at a much higher rate, or begins consuming at a lower rate, this debt will never be paid, and P_1 will have to write off the debt. Thus P_1 's savings will drop from 52 fish to just 2 fish, as illustrated in Figure 11, which again shows the resulting effect of the whole year's activity.

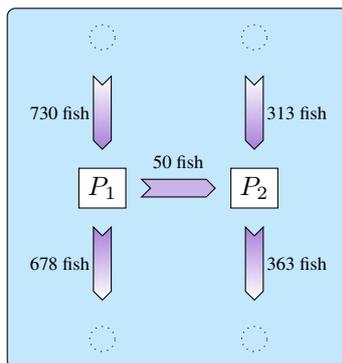


Figure 11: Whole year of P_1 and P_2 catching fish; P_2 defaults on debt

One way to interpret this sequence of events is to say that the demand for P_1 's fish of 1 fish per week was not real. The fish was supposedly bought with P_2 's net worth, but P_2 had neither enough net worth, nor any prospect of gaining it, to actually buy the fish. In practice, 50 fish were simply donated by P_1 to P_2 .

It may be that P_1 was perfectly happy to share some of the 730 fish with P_2 , or

it may not. In either case, the fact that P_1 had a false impression of resilience, which eventually had to be acknowledged in the catastrophic write-off of 96% of P_1 's savings, was potentially a huge problem. For example, P_1 might have already spent a great deal of effort in preparing for a two-week project to make a wooden knife to skin fish more efficiently, which would have to be abandoned when the impossibility of giving up the daily fishing work became clear.

7 Overview of the Economy

The whole economy can be modelled simply as:

- A huge number of people (natural people and corporations), each with a current net worth (their savings), and
- an even greater number of events which cause people's net worths to change, or in which services are provided by one person to another.

The net worth of the whole world is the sum of all the tangible assets owned by any person in the world. This is equal to the sum of all production since the beginning of time minus the sum of all consumption since the beginning of time.

Increases in net worth can only come from production of tangible assets, which involve effort on the part of producers. Reductions in net worth only come from consumption of tangible assets, which tend to benefit the consumers. Every other economic action involves only transfers or exchanges of net worth.

The net worth of a person P , NW^P is P 's savings—the stock available to P for:

- i Consuming (just the tangible assets)
- ii Exchanging in trade
- iii Giving without receiving (either by choice or by force)

When a person P is insolvent, there are some liabilities $\{D_i^P \mid i \in \{1, \dots, n\}\}$ which cannot be paid. The savings of the rest of the world are then in reality $\sum_{i=1}^n D_i^P$ lower than they believe.

Economic actions can be understood—both accurately and intuitively—in the form of diagrams showing the creation, transfer and destruction of net worth. Each economic action appears exactly once in either:

- a chain from producer to consumer (in the case of tangible assets or services), or
- a loop in which each participant has their net worth both increased and decreased by the same amount (in the case of a debt)

Seeing saving as the increase in net worth challenges the claim that there is a paradox of thrift. All people can save concurrently by producing more than they consume. In fact the promotion of one group's net consumption to counter other people's net production makes the whole economy fail to save at all. This makes the society extremely vulnerable to situations in which people are unable to produce at the rate at which they consume, such as natural disasters and famines.

References

- J. M. Keynes. *The General Theory of Employment, Interest and Money*. Harcourt, Brace and Company, New York, 1936. URL <http://www.marxists.org/reference/subject/economics/keynes/general-theory/index.htm>. [Retrieved 02-March-2019].
- M. McLeay, A. Radia, and R. Thomas. Money creation in the modern economy. *Bank of England Quarterly Bulletin*, 54(1), 2014. URL <https://www.bankofengland.co.uk/quarterly-bulletin/2014/q1/money-creation-in-the-modern-economy>. [Retrieved 02-March-2019].
- C. Menger. *Principles of Economics*. Ludwig von Mises Institute, Alabama, 1976. ISBN 978-1-933550-12-1. URL <https://mises.org/library/principles-economics>. [Retrieved 02-March-2019].
- A. Pierce. The Queen asks why no one saw the credit crunch coming. *The Telegraph*, 2008. URL <https://www.telegraph.co.uk/news/uknews/theroyalfamily/3386353/The-Queen-asks-why-no-one-saw-the-credit-crunch-coming.html>. [Retrieved 02-March-2019].
- D. Sanchez. How saving grows the economy. *Medium*, 2014. URL <https://medium.com/dan-sanchez/how-saving-grows-the-economy-95ca01ef2a7a>. [Retrieved 19-March-2019].
- J. B. Say. *A Treatise on Political Economy*. Augustus M. Kelley, New York, 1971. ISBN 0 678 00028 X. URL <https://mises.org/library/treatise-political-economy>. [Retrieved 02-March-2019].